Space Weather Forecast

Issued on Saturday, 16 December 2023 at 13:10 Local

This forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate-flares likely, and chance of Strong flares (R1-R3). G1-G2/Minor-Moderate Storms possible Days 1 and 2 (16-17 Dec) with CME arrivals, slight chance of G3/Strong Storms. Chance for S1/Minor Radiation Storm on Days 1 and 2 (16-17 Dec), risk reducing later in the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low with only Common-class flares observed in the past 24hrs, mainly from a region in the northwest of the disc. This was the region also responsible for Strong flare on the 14 Dec. This region does look as though it is decaying slightly, appearing to lose some magnetic complexity, although it is becoming difficult to tell as it continues to rotate towards the western limb. There are a total of ten sunspot regions, of which a region in the southeast has grown recently, but is not significantly magnetically complex. The other regions remain much smaller and simpler, although a couple of new regions are appearing near the east limb and may be more complex than can currently be seen.

An eruption near south centre disc occurred around 15/2100 UTC. We are awaiting imagery to see if any coronal mass ejection (CME) was produced from this, with its location suggesting that it might contain an Earth-directed component if so.

Solar Wind / Geomagnetic Activity: Solar winds continued to show the effects of a weak CME arrival at 15/1057 UTC. Wind speeds varied between elevated and background levels after the CME arrived, but have since settled to just below elevated. The interplanetary magnetic field (IMF) was initially moderate to strong after the CME arrived. It has since dropped to weak levels. The north-south component initially varied mostly moderately after the CME arrival, before becoming weak. Geomagnetic activity was Quiet-Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The count rate of energetic particles (high energy protons) gradually rose just above the S1/Minor Radiation Storm Level during the period, before dropping back to moderate levels.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity expected with the ongoing likelihood of Moderate class (R1-R2) flares and a chance of further isolated Strong class (R3) flares from the complex sunspot region in the northwest. This risk recedes later Day 2 and through Day 3 (17-18 Dec) as the region rotates off the disc.

Solar Wind / Geomagnetic Activity: There are a number of possible Earth-directed coronal mass ejections (CME). The first was expected to arrive early Day 1 (16 Dec) and may still arrive, but any impact is likely to be limited due to the faint nature of the CME. This may have been the cause of the weak CME arrival observed on 15 Dec but this is uncertain, and hence is low confidence. The Strong flare on Dec 14 produced a moderately fast CME which is likely to have

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an Earth-directed component, most probably arriving early on Day 2 (17 Dec). However confidence in this analysis is rather low. A further weak CME early on 14 Dec looks to be cannibalised by the Strong flare CME. It is possible that there is some weak coronal hole fast wind influence at present, but largely masked by the recent weak CME arrival. A further coronal hole may then enhance the solar wind speed to elevated levels on Day 3 or more likely Day 4 (18-19 Dec).

Geomagnetic activity is expected to be Unsettled (Kp3) at first, possibly rising to give spells of Active to G1/Minor Storm (Kp4-5) early on Day 1 with the first forecast CME arrival. The second CME arrival is likely to give G1-G2 Minor to Moderate storms (Kp5-6) early Day 2, with a slight chance of isolated G3/Strong storm intervals (Kp7). A return to mainly Quiet to Unsettled conditions (Kp1-3) is likely during Day 3, perhaps increasing again on Day 4 to Unsettled to Active (Kp3-4) with any fast wind enhancement.

Aurora Forecast: The forecast arrival of a CME during the early UTC hours of Day 2 (17 Dec) should see an enhancement of the auroral oval. Visible aurora are possible across Scotland and perhaps further south across northern England and Northern Ireland, however the local weather forecast is for extensive cloud cover across northern UK, so aurora sightings are probably unlikely.

Energetic Particles / Solar Radiation: The count rate of energetic particles (high energy protons) is at moderate levels after briefly rising above the S1/Minor Radiation Storm threshold. There is still a risk for this threshold to be reached over Days 1-2 (16-17 Dec) if any further significant flares occur. Forecast CME arrivals during this time may also help to increase proton levels. The risk of Radiation Storms gradually reduces later in the period as the responsible sunspot region rotates off the disc.

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Met Office Space Weather Forecast

Geomagnetic Storms:

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	60	20	5
Strong	G3	No	15	20	2	1
Severe	G4	No	2	5	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X Ray Flares:

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	60	50	40
Very Active	R3 to R5 X	No	25	25	10	5

Solar Radiation Storms - (High Energy Protons):

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	Yes	60	40	20	10
Very Active	≥ S3 *	No	5	5	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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